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(54) A remote identification system comprising passive identification devices.

(57) A system for remote identification of objects, comprising a transmitter, a receiver and a set of passive identification devices associated with the objects, which operate as a transponder for a receiver in response to operation of the transmitter. Each passive identification device has an LC-resonance circuit and a quartz crystal inductively coupled thereto. It is possible to use one quartz crystal as well as several quartz crystal having different frequencies, which are connected in parallel. Within a set of passive identification devices it is possible to use passive identification devices each containing one quartz crystal, said quartz cyrstals either having one and the same frequency or different frequencies, or passive identification devices containing 1, 2 and more quartz crystals having different frequencies, or a constant number of quartz crystals having different frequencies. The transmitter and the receiver are switched, whereby a time delay is provided between switching off of the transmitter and switching on of the receiver. The transmitter transmits a transmission signal at every frequency of the quartz crystals used, and the receiver demodulates in as many channels and performs a matched filter operation, after which correlation is carried out for final identification.

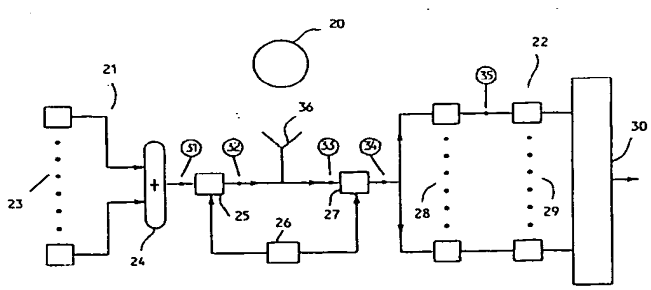

FIG. 5

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The invention relates to a passive identification device, comprising a resonance circuit, and to a system for remote identification of objects, comprising a transmitter, a receiver and a set of passive identification devices associated with the objects, which operate as a transponder for a receiver in response to operation of the transmitter.

Such a passive identification device and such a system are known in anti-pilferage applications. In fact identification in a narrower sense, namely detection, is concerned here. That is, objects to be secured against theft are not distinguished from each other, but only from objects not to be secured against theft.

The resonance circuit of the known passive identification device consists of a capacitor, which is connected to a small-sized coil, which provides magnetic coupling to an external field. Resonance is detected by means of a transmitter provided with a frequency-modulated generator sweeping around the resonance frequency. The receiver is then constructed such that it can discriminate between the resonance curve from the passive identification device and flatter responses from other objects in the region of detection. The detection range amounts to maximally a few meters thereby. The typical linear dimension of the passive identification device is 5 cm, whereby in practice, in order to avoid wave effects in the system, the quality factor of the passive identification device will not exceed 200 in a field having a frequency of considerably less than 200 MHz. Due to this low quality factor, in conjunction with the impossibility to produce these known passive identification devices with sufficient reproducibility and constancy of their resonance frequencies and the sensitivity of the system to objects not to be secured against theft, which generate a large signal at the receiver, the known system is inherently unsuitable for an identification system in a wider sense, which must also be able to identify objects of detection, which is why the known system leaves room for improvement as a detection system.

The object of the invention is to provide a reliable, low-cost, passive remote identification system.

In order to accomplish that objective the invention proposes a passive identification device of the kind mentioned in the preamble, which is characterized in that it is provided with a crystal coupled to the resonance circuit, as well as a system of the kind mentioned in the preamble, which is characterized in that the set of passive identification devices is composed of the proposed passive identification devices.

A passive identification device according to the invention may comprise one crystal or several crystals having different frequencies, which are connected in parallel.

The set of passive identification devices may consist of passive identification devices containing one crystal, with the same frequency for each passive identification device, or of passive identification devices containing one crystal, which are selected from a set of a number of crystals having mutually different frequencies.

The set of passive identification devices may also consist of passive identification devices, each containing a first number of crystals having mutually different frequencies, which are selected from a set of a second number of crystals, which is larger than the first number of crystals, having mutually different frequencies, or of passive identification devices containing different numbers of crystals, which are selected from a set of a number of crystals having mutually different frequencies.

The crystals are preferably quartz crystals, since they are small, inexpensive and reliable.

The resonance circuit is preferably a parallel circuit of a coil and a capacitor, since they may be small-sized in the present invention.

The coupling between crystal and resonance circuit is preferably an inductive coupling, since this prevents the series resonance of the crystal from being overloaded, whilst a good reproducibility can be obtained. In addition the coupling may be a branched or an isolated coupling. In both cases the coil may consist of an open wire loop, whereby the capacitor is connected across the ends of the wire loop. In the former case the crystal(s) is (are) connected to two branching points of the wire loop, whereas in the latter case the crystal(s) is (are) connected across the ends of a respective open wire loop, whilst all wire loops are located in proximity to each other. The wire loop may be a conductor track provided on a carrier.

The proposed identification device may be a label, a card or the like.

The proposed system, in which the set of passive identification devices is composed of passive identification devices containing one crystal, with the same frequency for each passive identification device, is preferably arranged such that the transmitter is switched for intermittently transmitting a transmission signal at the frequency of the crystal, and that the receiver is switched for intermittently receiving a response signal from a passive identification device receiving the transmission signal from the transmitter, demodulating the response signal, performing a matched filter operation and detecting the object based on the resulting output signal.

With the systems comprising said other sets of passive identification devices the system is preferably arranged in such a manner that the transmitter

is switched for intermittently transmitting a transmission signal consisting of a given number of summed signals at the respective frequencies of the given number of crystals, and that the receiver is switched for intermittently receiving a response signal from a passive identification device receiving the transmission signal from the transmitter, demodulating said response signal in a given number of channels, performing a matched filter operation in each channel and identifying the object based on output signals in said given number of channels.

The transmitter and the receiver may be switched at a frequency in the order of 1 kHz.

Preferably a time-delay is provided between switching off of the transmitter and switching on of the receiver, so that echoes from interfering objects in the scanned spaces have faded away. This time-delay may be in the order of 10 μs.

The transmission frequencies used should be below 30 MHz in case of an region of detection of 1 - 2 metres in each horizontal direction. In an advantageous embodiment of the system the transmission frequencies are substantially 27 MHz, for example frequencies of 26.91 - 27.10 MHz in steps of 10 kHz.

Preferably, but not exclusively so, the proposed passive identification device is used for identifying living objects, such as people and animals, or lifeless objects, such as goods and vehicles, with the proposed system being used for monitoring, security or logistic purposes. In this connection access control, electronic security, vehicle identification, monitoring of livestock and stock control may be considered, as well as theft prevention in shops or department stores.

The invention will be described in more detail hereafter with reference to the drawings, in which:

Figure 1 shows an embodiment of a passive identification device according to the invention in the form of a label;

Figure 2 shows a circuit diagram of a passive identification device according to the invention, with three crystals connected in parallel;

Figure 3 shows an equivalent circuit associated with Figure 2;

Figure 4 illustrates the impedance of a passive identification device according to Figures 2 and 3;

Figure 5 shows a strongly simplified block diagram of an embodiment of a transmitter-receiver for the system according to the invention; and

Figure 6 shows signal waveforms occurring at various points marked in the block diagram of Figure 5.

In the present description the term identification is also meant to include detection.

In Figure 1 an open wire loop 1 constitutes a coil, across whose ends 2 and 3 a capacitor 4 is connected, whilst a crystal 5 is connected to of two branching points 6 and 7 the wire loop 1. Of course the wire loop 1 may be formed on a carrier (not shown) by vapor deposition, or the coil 1 might consist of a plurality of windings in applications where this would not constitute a drawback. Although one crystal 5 is shown, several crystals 5, each having a different frequency, may be connected in parallel.

Figure 2 shows a circuit diagram associated with Figure 1, with three crystals 5 being used.

Referring back to Figure 1, the crystal 5 is preferably a quartz crystal, since it has a well-defined, stable and reproducible resonance frequency, as well as a high quality factor of about 105.

The coupling of the crystal 5 to the resonance circuit 1, 4 may take place in an inductive, isolated or capacitive, but not in a direct manner, since this will lead to overloading of the series resonance of the crystal 5, whereby in practice the drawback of capacitive coupling is that the coupling capacitor (not shown) must have values of a few picofarad or less, which are difficult to reproduce.

Figure 1 illustrates inductive coupling of the resonance circuit 1, 4 in the form of branching the coil 1, one winding in this case. In the case of isolated coupling an additional, loose wire loop (not shown) is used with the crystal 5. This latter possibility becomes interesting from a practical point of view, since the passive identification device may be given a possibly interchangeable identity afterwards, by attaching a crystal 5 plus wire loop to the carrier (not shown).

Due to the selection of a high frequency, for example 27 MHz, which selection will be discussed in more detail hereafter, the passive identification device may be very small-sized. With a coil 1 diameter of 4 cm, the self-induction of the coil 1 is 100 nH, from which it follows that for resonance at the said frequency the capacity of the capacitor 4 is 350 pF. A ceramic capacitor having this value is small and inexpensive and has very low losses, although it is also possible to use a paper capacitor or a capacitor formed by vapor deposition. Moreover, since it is possible to keep the capacity of the capacitor 4 below 1 nF, the resonance circuit 1, 4 has a high quality factor as a result of low losses, which are then determined by the coil 1, which has only one winding. When the passive identification device remains small in comparison with the wavelength, a high frequency is advantageous, in spite of the skin effect which occurs in the wire of the coil 1.

The degree of coupling of one or more crystals 5 to the resonance circuit 1, 4 influences the magnitude of the response signal from the passive identification device, which will be discussed here-

after, as well as the possibility of a correct identification of the passive identification device. As a rule of thumb the crystal 5 should exhibit a load of about 10 times its own series resistance. This results in a 90% dip in the resonance curve of the resonance circuit 1, 4, as will be seen hereafter in the description of Figure 4, at the frequency of the crystal or crystals 5, and thus in a practically maximal detection possibility of the crystal or crystals 5. On the other hand the crystal or each crystal 5 retains 10% of its unloaded quality factor, so that the dips resulting from different crystals 5 are sufficiently pronounced to enable reliable identification. All this implies that the time constant τ of the response signal from the passive identification device is given by 0.1 x 2 Qk/w, where Qk is the quality factor, which amounts to about 120 μs at the given frequency.

As already said before, Figure 2 shows a circuit diagram of a passive identification device with three crystals 5 connected in parallel, which are connected to a tap 8 of the coil 1 of a common resonance circuit 1, 4. Figure 3 shows an equivalent circuit depicting the crystals 5 as series resonance circuits 9, which have an unloaded quality factor Qx at different resonance frequencies w1, w2 and w3. The influence of the tap 8 (fraction γ) on the coil 1 occurs in the series resistance R1, which is connected with the loss-representing series resistance Rx of the crystals 5 as R1 = Rx/γ. The equivalent circuit of Figure 3 also illustrates the loss-representing resistance R0 of the resonance circuit 1, 4, together with the central frequency w0 and the quality factor Q0 thereof. The shunt capacity that is responsible for the parallel resonance of a quartz crystal 5 is small, and may be considered incorporated in the capacity C0. The parameter γ may be used for controlling the ratio R0/R1, which will be called the crystal load factor α. In order to appreciate the significance of this factor, we will now consider the impedance Z as seen across the terminals of the coil 1 as a function of the frequency. This transimpedance Z is directly proportional to the system response as given by the ratio between voltage received and current transmitted.

Figure 4 shows |z|, normalized at R0, as a function of the normalized frequency Ω, defined as Q0 (w/w0 - w0/w). The wide resonance curve 10 of the resonance circuit 1, 4 has its -3 dB points with Ω = ±1. The resonance frequencies of the crystals 5 are so far apart that 20 sharp series resonances fit between these -3 dB points, so that twenty crystals 5 can be used. In Figure 4 one of the crystal frequencies coincides with Ω -0, whilst the other two are as proximate as possible thereto. The crystal load factor α determines the depth and the width of the dip 11 in the main resonance curve 10. These characteristics are significant because the depth, the amplitude and the width determine the time constant of the natural response to be detected. In Figure 4 α = 10 applies.

When a set of passive identification devices is composed based on the passive identification device according to Figures 2 - 4, each passive identification device comprises three crystals 5 having mutually different frequencies, which are selected from a set of twenty crystals 5 having mutually divergent frequencies, so that there are 1140 possible identities, which number is given by the binomial coefficient 20 above 3; more generally m above k, whereby m > k > 1 applies. In the case mentioned a fixed value of k (=3) has been assigned to the number of crystals 5 in an identification device. The number of identities may be increased by rendering k variable, for example 1 - 3. Selection of k = 1 - 5 and m = 25 yields 68,405 identities, which is more than the set of codes possible with a 16-bit identification card. This will add to the complexity of the decoding process yet to be described, however. Also with applications where large numbers of identities are desired, however, the most obvious thing to do is select a fixed value of k; after all, if m = 25 and k = 12 is selected, this yields 5.2 million identities, which is sufficient to identify the entire Dutch fleet of cars.

For mere detection purposes the set of passive identification devices is composed of passive identification devices containing one crystal 5, with the same frequency for each passive identification device. Simple identification, that is with a relatively low number of identities, is possible with a set of passive identification devices consisting of passive identification devices containing one crystal, which are selected from a set of a number of crystals 5 having mutually different frequencies.

Referring to Figures 5 and 6, now the system for remote identification of objects will be further explained with respect to a transmitter-receiver with a common antenna, whereby the system comprises a set of proposed passive identification devices associated with the objects, which operate as a transponder for the receiver portion of the transmitter-receiver in response to operation of the transmitter portion of the transmitter-receiver.

In Figure 5 a passive identification device according to the invention is indicated at 20, the transmitter portion or the transmitter being indicated at 21 and the receiver portion or the receiver at 22, whilst reference numeral 36 indicates the antenna, a common antenna in this case. Figure 6 illustrates from top to bottom various signal waveforms 31 - 35 occurring at respective points in the diagram of Figure 5. Reference numeral 23 in Figure 5 indicates a number of modulators, for example 20, each containing a crystal-tuned oscillator (not shown) for the possible crystal fre-

quencies (twenty in this case), three of said frequencies, still with respect to the above-described embodiment, always being present in a passive identification device.

To be perfectly clear, the signal waveforms 31 - 35 of Figure 6 only relate to a single frequency. See signal waveform 31 in this connection, which is present at the output of a summing device 24 shown in Figure 5, which receives at its inputs the output signals from the modulators 23.

The amplifiers 25 and 27 in Figure 5 provide buffering, amplification and reception for the transmitter-receiver antenna 36. The timing is taken care of by the switching device 26, which may comprise a block-wave generator and which generates two switching signals, one for the transmitter amplifier 25 and one for the receiver amplifier 27.

The signal waveform 32 in Figure 6 is transmitted, whilst the signal waveform 33 is received back, whereby the damped oscillation 41 during the off-phase of the transmitter 21 indicates the presence of the passive identification device 20. Actually twenty frequencies are transmitted with this embodiment, whereas the passive identification device 20 responds to exactly three of these frequencies with the damped oscillation 41, thus revealing its identity to the receiver 22. Besides, in practice the damped oscillation 41 from the passive identification device will be much weaker than is suggested for the sake of clarity by the signal waveform 33. Suppression of the much stronger transmission signal 2 eventually leads to the signal waveform 34 at the output of the receiver amplifier 27. The timing or the switching of the transmitter 21 and the receiver 22 is determined by the following considerations. The time constant τ (= 120 μs) calculated before indicates the speed at which the oscillation 41 of the passive identification device is damped. If as a rule reception takes place during a time interval of 3 τ to 4 τ, followed by transmission for a similar period, this leads to a switching frequency of 1 kHz. In this connection it is important that a time-delay of 10 μs is provided between switching off of the transmitter 24 and switching on of the receiver 27, in order to be sure that all echoes from interfering objects in a scanned space have faded away. This delay provides a significant reliability gain in comparison with systems that use frequency sweeping.

It is furthermore noted in passing that all numerical values provided are approximation values and that it is possible to substantially depart from these values, depending on the particular application.

The "central" transmission frequency is selected so that there are no radiation effects, which means that all objects to be detected are present in the near field of the transmitter-receiver antenna. After all near fields attenuate to the third power with distance, the advantages being a very compact scanning area, which does not produce any outward interference, as a result of which Official requirements (PTT in the Netherlands) can be satisfied without any difficulty, whilst moreover little interference is caused by outside influences, and that the entire scanning area is simultaneously scanned in all directions, for example 1 - 2 metres in every horizontal direction, which provides an upper limit for the transmission frequency; with a wavelength of 10 m or more the frequency should namely be 30 MHz or less.

The transmission frequency is also selected in dependence on the passive identification device. The quality factor of the resonance circuit 1, 4 which makes the passive identification device present in the field detectable, should be as large as possible. The fact is that the response signal from the passive identification device is directly proportional to the quality factor of the resonance circuit. The quality factor of the crystals 5 should likewise be as large as possible, in order to achieve the largest possible resolution. Both said quality factors increase along with the transmission frequency. Besides, the switching frequency for the transmitter 21 and the receiver 22 for on/off operation may be raised with an increasing transmission frequency, which results in greater system reliability. Finally, with a higher transmission frequency the product of the self-induction and the capacity of the resonance circuit 1, 4 is smaller, so that a smaller-sized passive identification device can be used because of the possibility to use a smaller coil 1, whilst retaining suitable values for the associated capacitor 4. These considerations make it necessary to select the transmission frequency preferably as proximate to the said maximum frequency of 30 MHz as possible. The central transmission frequency of 27 MHz selected in the described embodiment is not compulsory, but has the additional advantage that the P.T.T. does not impose any restriction whatever. In other countries a different selection may be made.

Returning to the receiver portion 22 of the transmitter-receiver shown in Figure 5, a number of demodulators 28, twenty in this case, mixes the amplified response signal 34 in twenty channels pack to the baseband, which leads to the signal waveform 35 of Figure 6. For that purpose said number of demodulators comprises respective mixers (not shown), which multiply the response signal 34 by the respective frequencies generated by the number of modulators 23. Accordingly the modulators 23 and the demodulators 28 may each comprise a respective common crystal oscillator (not shown) for generating a respective transmission frequency and for use in demodulation by a re-

spective demodulator 28. All the same there is no synchronous or coherent detection, since the response signal 34 from the passive identification device necessarily has a free-running phase. The demodulators 28 are quadrature modulators. As an alternative for these asynchronous or incoherent demodulation envelope detection may be used. In that case respective frequency-selective devices (not shown) must be provided in front of the demodulators.

Reference numeral 29 indicates a number of correlation devices, likewise 20 in this case, which perform a matched filter operation. This implies that the signal waveform 35 of Figure 6, which generally will be lost in noise, is multiplied by the non-perturbed version of this signal waveform such as drawn in Figure 6, and integrated. This operation may be executed with analog as well as with digital means. For practical reasons a digital solution is more obvious, since the final identification device 30 shown in Figure 5 only needs to perform an operation on numbers, namely the results of twenty integrations, in order to establish the correct idendity of the passive identification device. For the described embodiment, with k = 3 and m = 20, this operation is very simple, namely selecting the three largest of twenty numbers presented by the correlation devices 29. Finally an identity number ranging from 1 to 1140 is computed with the combination of three numbers that has been found.

The reliability of the result obtained increases with correlation time. Dependent on the application the time duration of exposure of the passive identification device in the scanned area may vary. If this is for example set at 0.1 s, more than 100 response signals 34 can be correlated at a switching frequency of 1 kHz. In that case a signal-to-noise ratio of 0 dB proves to be sufficient for reliable identification, with an error probability of 10-5. Indeed a great many variants to this principle are possible. The optimum receiver 22 for example does not just sum 100 integration partial results, but the square of these interim results. In that case we have an optimum n-fold time diversity. Selection of a variable value k will of course increase the complexity of the final identification device 30. In that case optimum decoding for the most probable identity must be carried out. Possibly error correction may be carried out by means of redundance in the identity code.

Claims

1. A passive identification device comprising a resonance circuit, characterized in that it is provided with a crystal coupled to said resonance circuit.

2. A passive identification device according to claim 1, characterized in that it is provided with several crystals having different frequencies, which are connected in parallel to said resonance circuit.

3. A passive identification device according to claim 1 or 2,characterized in that the or each crystal is a quartz crystal.

4. A passive identification device according to any one of the preceding claims, characterized in that said resonance circuit is a parallel circuit of a coil and a capacitor.

5. A passive identification device according to any one of the preceding claims, characterized in that the coupling between the crystal and the resonance circuit is an inductive coupling.

6. A passive identification device according to claims 4 and 5, characterized in that said coil consists of an open wire loop, that said capacitor is connected across the ends of said wire loop and that said crystal or said crystals is or are connected to two branching points of the wire loop.

7. A passive identification device according to any one of the claims 1 - 5, characterized in that the coupling between the crystal and the resonance circuit is an isolated coupling.

8. A passive identification device according to claims 4 and 7, characterized in that said coil consists of an open wire loop, that said capacitor is connected across the ends of said wire loop and that the crystal or the crystals is or are connected across the ends of a respective open wire loop and that said wire loops are located in proximity to each other.

9. A passive identification device according to any one of the preceding claims, characterized in that it is formed in the shape of a label, a card or the like.

10. A system for remote identification of objects, comprising a transmitter, a receiver and a set of passive identification devices associated with the objects, which operate as a transponder for a receiver in response to operation of the transmitter, characterized in that said set of passive identification devices is composed of passive identification according to any one of the preceding claims.

11. A system according to claim 10, characterized in that said set of passive identification devices consists of passive identification devices containing one crystal, with the same frequency for each passive identification device.

12. A system according to claim 10, characterized in that said set of passive identification devices consists of passive identification devices containing one crystal, which are selected from a set of m crystals having mutually different frequencies, whereby m > 1.

13. A system according to claim 10, characterized in that said set of passive identification devices consists of passive identification devices, each containing k crystals with mutually different frequencies, which are selected from a set of m crystals having mutually different frequencies, whereby m > k > 1.

14. A system according to claim 10, characterized in that said set of passive identification devices comprises passive identification devices containing different numbers of crystals, which are selected from a set of m crystals having mutually different frequencies, whereby m > 1.

15. A system according to claim 11, characterized in that said transmitter is switched for intermittently transmitting a transmission signal at the frequency of the crystal, and that said receiver is switched for intermittently receiving a response signal from a passive identification device receiving the transmission signal from the transmitter, identifying the response signal, performing a matched filter operation and detecting the object based on the resulting output signal.

16. A system according to claim 12, 13 or 14, characterized in that said transmitter is switched for intermittently transmitting a transmission signal consisting of m summed signals at the respective frequencies of said m crystals, and that said receiver is switched for intermittently receiving a response signal from a passive identification device receiving the transmission signal from the transmitter, demodulating said response signal in m channels, performing a matched filter operation in each channel and identifying the object based on output signals in said m channels.

17. A system according to claim 15 or 16, characterized in that said transmitter and said receiver are switched at a frequency in the order of 1 kHz.

18. A system according to claim 15, 16 or 17, characterized in that a time-delay is provided between switching off of said transmitter and switching on of said receiver.

19. A system according to claim 18, characterized in that said time-delay is in the order of 10 µs.

20. A system according to any one of the claims 10 - 19, characterized in that said transmission frequency is lower than 30 MHz or that said transmission frequencies are lower than 30 MHz.

21. A system according to claim 20 , characterized in that said transmission frequency is 27 MHz or that said transmission frequencies are substantially 27 MHz.

22. The use of the passive identification device according to any one of the claims 1 - 9 for identifying living objects, such as people and animals or lifeless objects, such as goods and vehicles.

23. The use of the system according to any one of the claims 10 - 21 for monitoring, security or logistics.

24. A transmitter for a system according to claim 15 or claim 15 and any one of the claims 17 - 21, characterized in that said transmitter comprises a modulator for generating a signal at the frequency of the crystal, a transmitter amplifier for amplifying the output signal of the modulator, a switching device for switching the transmitter amlifier on and off at a predetermined frequency, and a transmitter antenna for intermittently transmitting the output signal of the transmitter amlifier as the transmission signal.

25. A transmitter for a system according to claim 16 or claim 16 and any one of the claims 17 - 21, characterized in that said transmitter comprises m modulators for generating m signals at the respective frequencies of the m crystals, a summing device for summing said m signals, a transmitter amplifier for amplifying the output signal of the summing device, a switching device for switching the transmitter amplifier on and off at a predetermined frequency, and a transmitter antenna for intermittently transmitting the output signal of the transmitter amplifier as the transmission signal.

26. A receiver for a system according to claim 15 or claim 15 and any one of the claims 17 - 21,

characterized in that said receiver comprises a receiver antenna for receiving the response signal from a passive identification device of the system, a receiver amplifier for amplifying the output signal of the receiver antenna, a switching device for switching the receiver amplifier on and off at a predetermined frequency so as to suppress the transmission signal likewise received by the receiver antenna, a demodulator for demodulating the output signal of the receiver amplifier, a correlation device for performing a matched filter operation on the demodulator's output signal and a final identification device for delivering a detection signal based on the output signal of the correlation device.

27. A receiver for a system according to claim 16 or claim 16 and any one of the claims 17 - 21, characterized in that said receiver comprises a receiver antenna for receiving the response signal from a passive identification device of the system, a receiver amplifier for amplifying the output signal of the receiver antenna, a switching device for switching the receiver amplifier on and off at a predetermined frequency so as to suppress the transmission signal likewise received by the receiver antenna, m demodulators for demodulating the output signal of the receiver amplifier in m channels, m correlation devices for performing a matched filter operation in each channel, and a final identification device for identifying the passive identification device based on the output signals of said correlation devices.

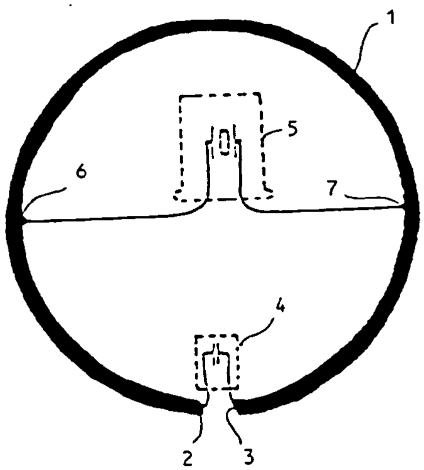

FIG. 1

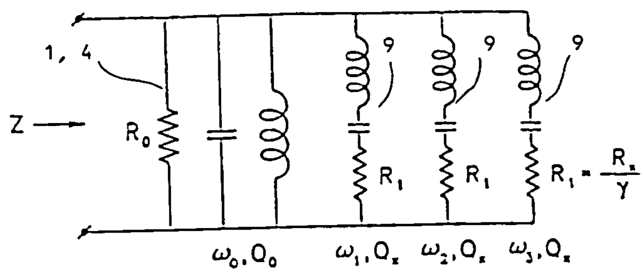

FIG. 3

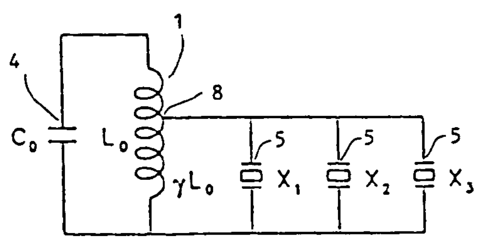

FIG. 2

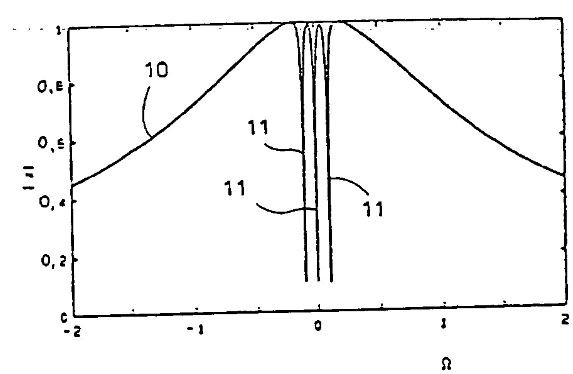

FIG. 4

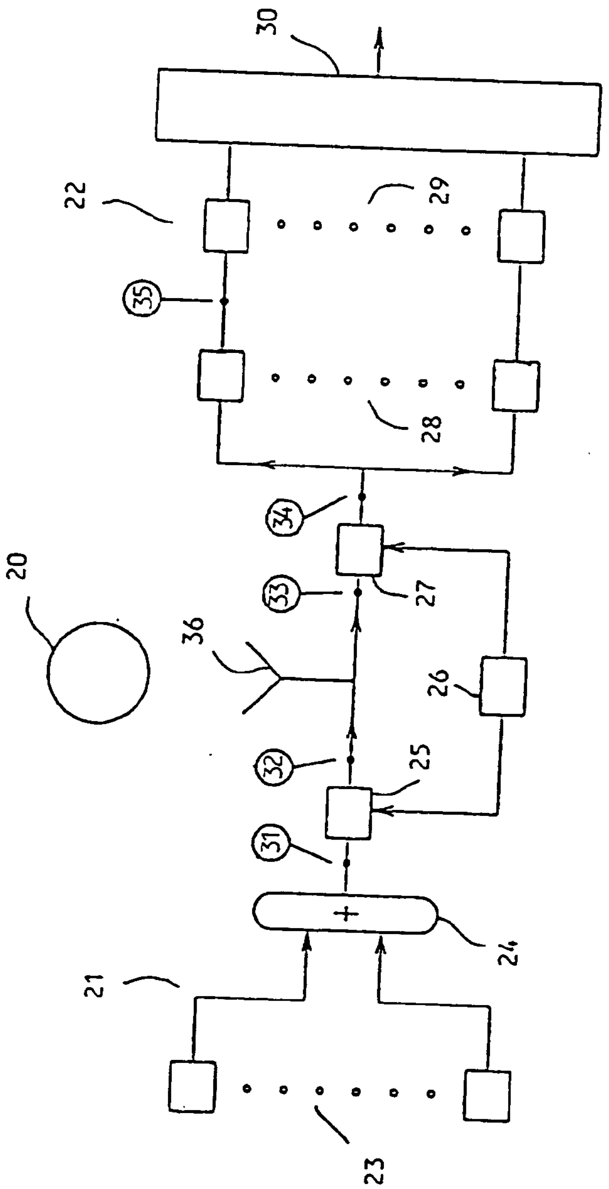

FIG. 5

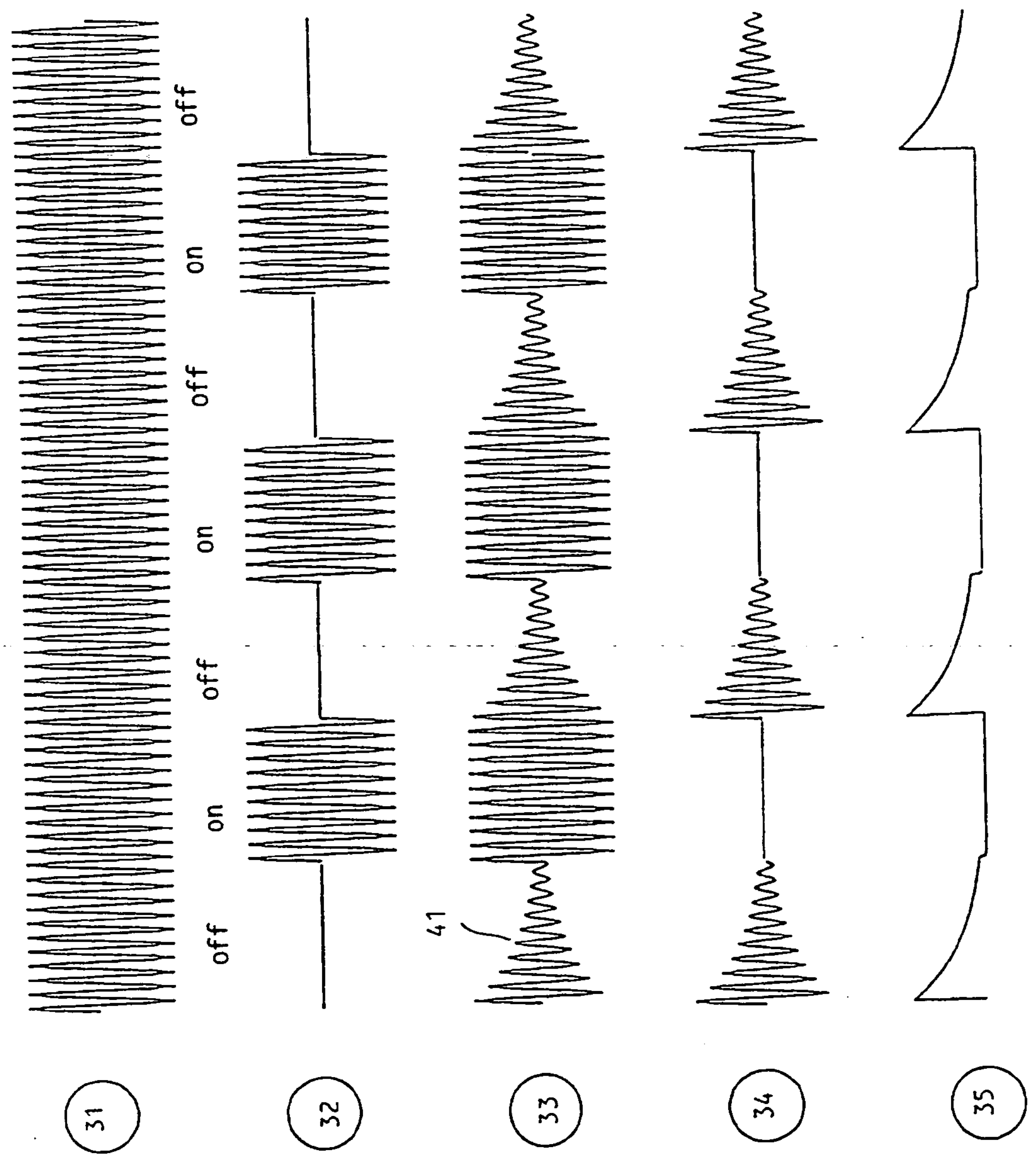

FIG. 6

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 93 20 0396

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Y	EP-A-0 131 440 (MINNESOTA MINING AND MANUFACTURING COMPANY) * figure 1 * * page 3, line 6 - page 4, line 24 * * page 7, line 35 - page 9, line 13 * ---	1,3, 9-11,15, 20,22,24	G08B13/24
Y	WO-A-8 800 785 (B.I.INCORPORATED) * figures 1,3,4,7-9 * * page 10, line 28 - page 11, line 6 * * page 12, line 1 - line 13 * * page 13, line 12 - line 26 * -----	1,3, 9-11,15, 20,22,24	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			G08B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	26 APRIL 1993	WEISS P.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

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